THE STRANGER AMONGST US: URBAN RUNOFF, THE FORGOTTEN LOCAL WATER RESOURCE

Neal Shapiro
City of Santa Monica
Santa Monica, CA.

Abstract

Urban runoff is an ignored and misunderstood local water resource. As a pollution problem, runoff is the single greatest source of water pollution in Southern California, specifically in the Santa Monica Bay and as an ecological problem causes degradation of water quality and impairment of beneficial uses, threatening the long-term health of marine ecosystems and local economies. As a water resource, capturing stormwater for groundwater recharge can add a significant regional water supply, lowering the region's dependence upon imported water, which causes ecological degradation and water supply disruption to distant watersheds. The City of Santa Monica adopted a strategy to solve both problems: harvest stormwater, treat it and infiltrate back into the ground, and keep a pollution source out of the Bay. The City's comprehensive watershed-urban runoff management approach includes: (1) an ordinance to require the harvesting of stormwater runoff from new development; (2) a philosophy of treating all dry weather and some wet weather urban runoff leaving the City; (3) a first-of-its-kind innovative recycling facility for dry weather runoff.

This runoff management approach allows for the development of a toolbox of innovative structural solutions, best management practices (BMPs), which can be tailored for each site's specific land use characteristics. A critical component of this successful toolbox is the unique management style: a shift from the traditional stormwater management approach of plumbing land, paving it over to move the maximum amount of runoff to receiving waters, to a low-impact site design approach of allowing the land to work within nature's hydrologic cycle, maximizing permeability and runoff infiltration into the ground.

The City ordinance requires low-impact BMP designs in new developments. These design techniques harvest precipitation and infiltrate it back into the ground, keeping urban runoff and its pollutants out of receiving waters. Not only are water quality objectives improved and beneficial uses restored as runoff is treated while passing across, through and into landscapes, but aquifers are recharged for future extraction.

The Santa Monica Urban Runoff Recycling Facility turns a perceived "waste" product into a natural resource, a commodity, for reuse in landscape irrigation and indoor plumbing, and eliminates dry weather runoff into the Bay. Secondary project goals include public outreach through urban runoff educational exhibits at the facility, and strong artistic and architectural elements into a highly functional design and community asset.

Introduction

Studies cite contaminated urban runoff as the greatest single source of water pollution in the country. This non-point source urban runoff pollution problem in Southern California, specifically in the Santa Monica Bay, is one such major ecological problem, threatening the long-term health of marine ecosystems and local economies. The City of Santa Monica took a three-prong integrated management unique approach to this problem:

- Ground-breaking municipal ordinance to require the harvesting of stormwater runoff from new development;
- City goal of treating with Best Management Practices (BMPs) urban runoff from new City development and all urban runoff from its storm drain system before runoff leaves City boundaries; and
- Construction of a year-round dry weather runoff facility to treat and reuse in place of imported potable water urban runoff, the country's first dry weather urban runoff recycling facility.

The City redirected its approach to managing urban runoff from the traditional approach of moving runoff as fast as possible from the City and into the Bay, to a watershed approach in which the land is viewed as part of the hydrologic cycle and can absorb runoff for treatment and storage, keeping runoff out of the Bay. Instead of disrupting the water cycle, the City objective is to work with nature. Figure 1 demonstrates this approach, making a building and its surrounding hardscapes appear invisible to precipitation and runoff through the placement of BMPs and site planning so that rain runoff goes back into the ground to the maximum extent possible, instead of running off hardscapes into the street and water ways.

Figure 1. Making a building seem like it is not there in terms of precipitation and stormwater runoff to the land. On right, existing building and its hardscapes collect rain and runoff, and direct them onto the street and into the Bay, the Traditional Approach. On left, strategically-placed BMPs within the landscape receive runoff from the building for infiltration, keeping runoff out of the street and giving the appearance to the land that the building is not there, the Low-Impact Approach.

Studies (May, 1997; Schueler, 1995; Schueler, 1994) have shown that as impermeable surfaces increase, replacing permeable surfaces, water quality decreases and impacts on aquatic flora and fauna increase, even with as small as 5-10% increase of impermeable over permeable.

Many studies have documented the health risks and dangers to beach-users and aquatic habitats and life from urban runoff. The Southern California Coastal Water Research Project, a leading marine research group in Southern California, reported that storm water and urban runoff are the leading source of water pollution in the Los Angeles area (Cone, 2000); storm water pollution has increased 200-700 percent during the last 20 years. Stormwater has become a lethal cocktail of pollutants that now constitutes the single greatest source of water pollutants, contributing 50-60 percent of the pollutant load.. According to the US EPA, urban stormwater is the largest source of water quality damage in estuaries, the second largest for wetlands degradation, third largest impairment of lakes and fourth largest source of river damage (Mehta,

2002; Sheppard, 2000; Coastal Alliance, 2000; Los Angeles County, 2000; American Oceans Campaign, 2000). An epidemiological study (Haile, 1996) showed that people who recreate near flowing storm drains are much more likely to contract intestinal, ear, and nose illnesses. In light of numerous studies mentioned above and with the passage of stricter regulations for urban runoff discharges, the City leadership believes that all dry weather and some initial wet weather runoff leaving the City should receive some treatment to remove pollutants of concern before entering the local receiving water body, the Santa Monica Bay. To achieve this goal, the City has installed BMPs in many of its storm drain outlets and in catch basins within the storm drainage system. The City has every expectation to have BMPs in all storm drain outlets in the near future.

The purpose of this paper is to describe the City's urban runoff management program and some examples of BMPs that have been implemented to reduce problems associated with urban runoff, namely water quality and quantity issues. The City's program integrates the resources of many departments to comply with urban runoff regulations and the City's Sustainable City Program. Instead of disconnecting staff, the program seeks to connect personnel and goals to achieve success. The program is a hands-on, proactive and watershed approach in which solutions seek to mimic nature, not disrupt it. Ultimately, the program seeks to convert a perceived waste into a valuable resource and at the same time keep pollutants out of the Bay.

Santa Monica

Santa Monica is about 20.5 kilometers^2 (8.1 miles^2) in size with a residential population about 90,000. The daytime population increases by more than double. The City is surrounded by the Pacific Ocean (Santa Monica Bay) on the west, Santa Monica Mountains to the north, and cities of Los Angeles and Venice to the east and south. Attractive beaches and the Santa Monica Pier, pleasant year-round climate and proximity to attractions in Southern California make Santa Monica a popular destination. The City is completely built out.

The City's urban runoff management program is strongly supported by a City Council and management concerned about environmental stewardship and responsibility. To this end, the City enacted a Sustainable City Program (Santa Monica, 1994) to promote sustainable practices, including the reduction of pollution found in urban runoff. The Council has a history of political activism for environmental protection, which is critical to a City that depends upon a healthy Bay to support a healthy economy.

Due to recent media reports about the dangers of urban runoff and impacts to beach-goers and aquatic life, the City responded quickly and implemented many changes in how the City does business on a daily basis. The rest of this paper describes the many programs to improve urban runoff quality and reduce runoff quantity.

Source Control & Prevention

The best solution to pollution found in urban runoff is to prevent pollutants from coming in contact with urban runoff, whether dry weather runoff or storm runoff. The pollutants of concern are familiar to us: petroleum products from vehicular use, heavy metals from vehicle brakes, organic chemicals and fertilizers (nutrients) from lawn care use, overwatering of landscapes, broken irrigation systems, sediments from exposed land, detergents from cleaning hardscapes, and pathogens from pets, wild animals and transients.

Education

The City has printed materials that are distributed to residents and businesses, explaining the problems associated with urban runoff and suggested solutions. People can obtain these materials from City offices,

at community events, through the mail, at City-sponsored presentations, or from the City's web site. The City also collaborates with other municipalities and regional groups to disseminate educational materials through newsprint and radio.

Signage

The City maintains signage on all City catch basins, warning people not to dump materials into basins, and providing a phone number to call in incidents of dumping. Unfortunately, a mix of materials, some hazardous, still finds its way into catch basins and storm drains. Over the years, the City has used painted stencils, ceramic tiles and thermoplastic stencils to alert people about dumping materials into the City's storm drain system.

The City also maintains signage on the Pier, warning visitors not to dump materials over the side and into the Bay, nor to feed the birds. Dumping materials over the side, such as food and fish guts, attracts birds, and birds defecate into surrounding waters, adding pathogens.

Some City parks and pet walk parks contain dispensers with bags to clean up after pets for pet-owners who forget to bring bags with them. A City ordinance requires that anyone walking a pet outdoors must have a visible means of cleaning up after the animal.

The Santa Monica Urban Runoff Recycling Facility (discussed below) has numerous educational signs to explain what urban runoff is, its causes, and solutions. The City has additional plans for signage at new installations of BMPs so that people can learn more about runoff and how to prevent pollution.

Good House-Keeping Measures

The City's Urban Runoff Pollution Mitigation (Santa Monica, 2000) ordinance requires people in existing buildings or at existing properties without new or redevelopment to take steps to prevent pollutants from coming into contact with urban runoff. For example, people should clean up any spilled household hazardous materials immediately. Lawn care chemicals should be used as per instructions and not overused, nor applied before rain. Sprinkler systems should be properly maintained; any leaks should be repaired immediately. Containers of chemicals and trash receptacles should not be left outside uncovered.

Construction BMPs

The Mitigation ordinance also requires construction sites to be well maintained. Responsible parties at a construction site must take steps to prevent pollutants from coming into contact with urban runoff, and to prevent erosion and the escape of polluted runoff and sediment from a site. As with Good House-Keeping BMPs, containers of chemicals must not be left open and exposed to the elements. Trash containers must be covered. A sediment rack must be at the entry/exit to minimize tracking sediments offsite. Mounds of dirt must be covered to prevent wind and water erosion offsite. These are some examples of BMPs to prevent pollutants from entering storm drains.

Figure 2. Concrete washouts are collected for disposal instead of released to the street, storm drain system and ocean.

Onsite Treatment

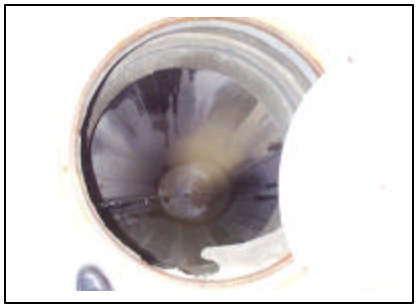
The Urban Runoff Pollution Mitigation ordinance requires new developments that exceed a specific threshold to incorporate best management practices, BMPs, such as infiltration trenches, french drains, permeable paving, biofilters and other low-impact structures into the post-construction design of a project. The design should be linked to how urban runoff will be managed onsite instead of dumping the problem into the public right-of-way. The express purpose of these low-impact development techniques is for harvesting precipitation, infiltrating it back into the ground and keeping urban runoff and its low-level pollutants out of receiving waters. Not only is water quality improved as the runoff passes through soil, but aquifers are recharged for future extraction.

Private & Public Development: Infiltration Trenches, Biofilters, Permeable Paving

A menu of BMPs is available to choose the best ones to incorporate into the design of a new building. These are post-construction BMPs to harvest, infiltrate and treat runoff. As shown in Figure 1, the goal is to design a low-impact development that minimizes the hardscapes, maximizes permeable surfaces and returns as much water as technically possible into the ground. The most common BMP for single-family developments is the infiltration trench, a sub-surface retention basin filled with large gravel, stackable plastic pallets or long concave-shaped plastic cylinders to store a certain amount of runoff for infiltration. Surface infiltration depression basins in yards also serve to retain runoff for infiltration. Biofilters and swales are other BMPs suitable for site-specific situations. Porous concrete and permeable paving products, modular and rolled, replace asphalt and concrete for parking lots, driveways and alleys.

Effectiveness

To date, over 600 new developments, including single-family, multi-family, commercial and City, have implemented this requirement of post-construction BMPs, keeping over 4,540,000 liters (1,200,000 gallons) of runoff out of the Bay per 0.25 centimeters (0.10 inch) or greater storm. To put this in perspective, this amount of water, if harvested and used directly represents about 9% of daily water use. Moreover, the City contains about 22,500 parcels. About 2.5% of properties in the City have had to comply with the ordinance and install BMPs since 1995. The City recognizes that each project is site-specific and in some cases BMPs will not be possible onsite. The ordinance allows for variances.



Figures 3, 4. On left, cylindrical infiltration system some 20 feet deep under a subterranean garage for a multi-family building receives roof runoff during a storm and infiltrates into the ground; on right, common box-shaped, sub-surface infiltration trench at a single-family development collects roof and other hardscape runoff for infiltration.

Figures 5, 6. Use of plastic in-fill instead of gravel allows greater storage volume, 94% versus 40%. On left, sub-surface infiltration trench filled with *RainStore*; on right, trench filled with *StormCell*.

Figure 7, 8. On left, biofilter/swale system in parking lot of a school receives all runoff. For almost all storms, all runoff remains onsite for infiltration. On right, permeable pavers in a parking lot of a business allows runoff to infiltrate instead of run off into the street.

Figures 9, 10. On left and right, before and after photos of *Grassy Pavers* permeable pavers at a multi-family building in the parking stalls. Left photo shows pavers exposed before infill. Right photo shows pavers filled with colored rock.

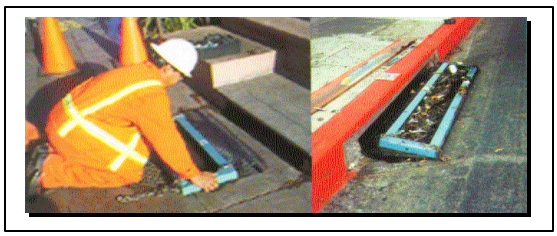
Figure 11. Porous concrete V-swale in a City alley to harvest runoff and reduce flooding of adjacent properties.

Public Surface Systems

As mentioned earlier, City leadership believes that all dry weather and some initial wet weather runoff leaving the City should receive some treatment to remove pollutants of concern before entering the local receiving water body, the Santa Monica Bay. The City continues to install BMPs in its storm drain system. The City has every expectation to have BMPs in all storm drain outlets in the near future.

Catch Basin Inserts

The newest generation of basin and storm drain BMPs, inserts and screens, avoid many of the pitfalls of the earlier efforts—pieces of wood over the openings of catch basins. Water can pass into the catch basin, trash can be removed, and high flows still bypass into the basin, avoiding flooding. Many insert types are on the market. Some filter only trash and debris; some filter both trash and soluble chemicals via a special filtering medium. The City uses both types of strategies. The City places inserts for trash and debris in areas of high pedestrian traffic, such as the downtown Promenade area. Inserts that filter hydrocarbons, in addition to trash, are placed along streets with automotive businesses.



Figures 12, 13. A catch basin insert, *DrainPac*, captures trash and debris, preventing these materials from entering the receiving waters.

Catch Basin Screens

With inserts, City staff must clean them out on a regular basis to maintain the removal efficiency of the BMP, a time-consuming and costly requirement, especially in confined spaces. With screens attached to the curbface, trash and debris are kept out of the runoff, water can pass into the basin or drain, and street sweepers or City staff can remove easily these materials. However, if not properly installed, vehicles can brush against screens and damage both screens and vehicles. And in some installations, flooding might be an issue if the screens are covered with trash or in a flood-prone location.

Figure 14. Catch basin screen operating during storm. Water can flow through the openings while keeping trash out.

The City has found inserts and screens to be effective when the best device is chosen for a site, installed properly and maintained regularly. Many other types of BMPs that fit into catch basins and storm drains exist. More information about these BMPs, and those used by the City, is available from the author.

Public In-Line Systems

The City installed a number of these BMP devices as off-line centralized treatment systems. The advantage of centralized BMPs is that all the collection of pollutants and maintenance occurs in one location, instead of City crews driving to hundreds of locations to clean BMPs. Time and money spent for maintenance are reduced. To date, the City has found these devices very effective in removing trash, debris, oil and grease, and solubles attached to sediments. City staff is gathering data on amounts of solid pollutants removed from catch basins, storm drains and in-line BMPs, as well as characterizing pollutant types. These devices also allow the City to pinpoint sources of some pollutants depending upon BMP locations.

Many other types of in-line BMPs that fit into storm drain systems exist. More information about these BMPs, and those reviewed by the City, is available from the author.

Figures 15, 16. Left, muffler and concrete pieces captured in a *CDS unit* during a rain storm. Right, trash, mostly plastics, removed by the same *CDS unit* (Continuous Deflective Separation). This *CDS unit* receives runoff from the City's highly congested downtown area, rich in pedestrians, visitors, trendy shops and restaurants, and the weekly Farmer's Market.

Santa Monica Urban Runoff Recycling Facility (SMURRF)

The SMURRF is a first-of-its-kind facility that harvests on an annual basis dry weather urban runoff (93% of the City's total runoff) from the City's two main storm drain lines, treats the runoff through five systems, and reuses the new water resource for landscape irrigation and indoor toilet flushing. Santa Monica has become a leader in its efforts to safeguard and enhance the natural environmental and the community's health through innovative programs and policies.

What is truly revolutionary about the SMURRF is that not only does it represent an innovative 'wastewater' (not really wastewater) treatment facility, but it also represents a critical shift in philosophy and management of a natural resource. The traditional perspective is to dispose of a waste product "out of site, out of mind." In the case of urban runoff, the City has chosen a watershed perspective, transforming a waste product--urban runoff--into a valuable local natural resource.

Figure 17. The Santa Monica Urban Runoff Recycling Facility.

This project is an outstanding example of how the City effectively integrated art, engineering, and education to develop a project that is embraced by the public. This project safeguards and enhances water resources, prevents harm to the natural environment and human health, and enhances the community and local economy for the sake of current and future generations. The SMURRF is also an example of how cities work together to solve a shared problem. In this case, Santa Monica and Los Angeles are partners in this project. Some 1.1 million liters (300,000 gallons, almost 1 acre-foot) per day of dry weather runoff are being diverted from the ocean, treated to a high level and reused, or treated and returned to the ocean, removing a pollution source, especially pathogens.

SMURRF Project Goals

The primary objective of the SMURRF, which began operations in February 2001, is to dramatically reduce, if not eliminate, dry weather urban runoff pollution into Santa Monica Bay. To date, this goal is being met. Secondary project goals include raising public awareness about problems and solutions of urban runoff pollution through educational exhibits at the facility and combining strong artistic and architectural elements into a highly functional design. These goals have also been met through regular tours for interested visitors, from around the world: tourists, engineers, government officials, students and residents.

In addition, and no less important than any other secondary goal, the development of an additional water source for use throughout the City is critical. If the City has to treat urban runoff anyway to meet stricter regulations, why dump the treated effluent into the Bay? Is there not an advantage to reusing the treated local water resource and reduce imported water supplies? Every acre-foot of water recycled through the facility equates to one less acre-foot of potable water that must be imported from Northern California and the Colorado River. In doing so, the SMURRF benefits the entire region as well as Santa Monica.

Water Quality Challenges of Dry Weather Flow

Dry weather runoff captured by the SMURRF originates in a 153 kilometers^2 (4,200-acre) drainage area in the cities of Santa Monica and Los Angeles. Sources of dry weather runoff arise from the inefficient use of potable water by people: over-irrigation, broken irrigation systems, washing of paved surfaces and business equipment, car washing on hard surfaces, pool draining, leaking water pipes and hydrants, and illegal dumping. The average daily flow is estimated to be 1.1 million liters (300,000 gallons) per day, which represents slightly more than two percent of Santa Monica's overall water demand of 49 million liters (13 million gallons) per day. The facility has a capacity of 1.9 million liters (500,000 gallons) per day.
A variety of pernicious contaminants are found in urban runoff. The presence and concentration of these contaminants appear to vary significantly over time. Contaminants found in the dry weather runoff treated by the SMURRF include:

- Suspended and Dissolved Solids
- Oil and Grease
- Trash and other debris
- Pathogens
- Heavy metals (lead, copper, zinc, and chromium)

Initial laboratory tests of influent and effluent SMURRF water samples confirm significant reductions of these pollutants when found at elevated levels in influent.

Demand Challenges for Recycled Water

The two most likely uses for recycled urban runoff are landscape irrigation and toilet flushing in dual-plumbed buildings. To date, recycled water is being used for irrigation at the City's cemetery and two parks, and along a section of the Santa Monica Freeway within City boundaries. Additional users for indoor flushing will come online over the next few months at a major commercial development and next few years at the City's new Public Safety Facility next to City Hall and an international consulting firm.

Treatment Challenges of Urban Runoff

The five-stage treatment train at the SMURRF consists of bar screens, flow equalization, air floatation, microfiltration, and UV disinfection. Because the SMURRF is a new system, combining proven technologies to treat a new water resource presents challenges. Pre-treatment is critical to remove solids and sediments that can foul secondary and tertiary treatment systems. Daily maintenance is required. Oil and grease need to be monitored to avoid high concentrations (from spills) from entering the facility and exceeding the system's parameters. The microfiltration system requires special monitoring to ensure proper operation and long-term durability and reliability. A major challenge is the control of algae, which is very common in urban runoff. Initial designs required the injection of a background level of chlorine within the distribution line. However, the City has found that algae grows almost everywhere within the facility, especially in the finished reservoir. Weekly cleaning is required to prevent the buildup of algae. The City is considering adding chlorine earlier in the treatment train to reduce algal growth.

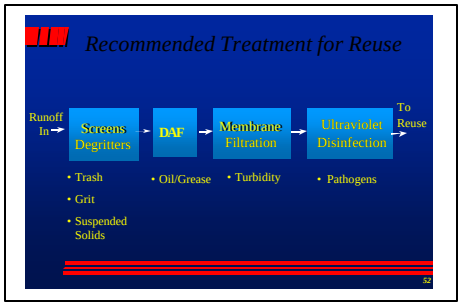


Figure 18. Diagram of SMURRF treatment train.

Challenges of Public Education and Artistic Allure

Placing a treatment facility near a prominent tourist site, the Santa Monica Pier and attractive sandy beaches, presented many challenges. The City took extraordinary steps to include educational, artist and architectural features, bringing drama to signage, landscape, and architecture; presenting educational material in a fresh fashion; and providing talking points for visitors. These features are key elements of a public information campaign that stresses the future importance of stormwater and wastewater recycling as a local water resource.

Because the SMURRF is open continuously, other types of challenges occur, the types of social challenges presented by youth and those without shelter. The City has had to balance the openness and unmonitored design of the SMURRF against the need for operational continuity and system security. During the first year of operation, City staff visit the facility daily for maintenance and damage control, in addition to its maintenance of the City's other water distribution systems: potable, waste, storm and recycled.

The daily activity of SMURRF reduces pollution into the Santa Monica Bay and provides a sustainable alternative water supply for the City of Santa Monica, with the displacement of up to four percent of potable water demand. The supply is sustainable in the sense that society is wasting hundreds of thousands of gallons a day through inefficient uses of water.

The collaborative design approach between the artist, architect, engineer, and public works department has transformed a potentially unsightly treatment facility into an important community asset. The more than 2 million visitors who come to the Santa Monica Beach and Pier each year will have an opportunity to learn about the benefits of pollution prevention and watershed protection.

The SMURRF is a reflection of the shift in how society manages all water resources. No longer is the traditional approach of removing any and all water resources from our midst acceptable. In a time of unstable, unreliable potable water supplies, water management needs to shift from the old traditional approach of over tapping existing potable supplies and think outside the box – use to the maximum extent practicable all existing and local water supplies, with an emphasis on water efficiency and conservation -- water efficient appliances and landscapes, elimination of leaks, and reuse of "waste" water supplies.

Funding Resources

The City has been fortunate to have a stormwater utility fee, an annual fee incorporated into the annual property tax bill. This annual revenue source is approximately $1.2 million. However, with the additional requirements on municipalities from regulations, such as the new NPDES permit and TMDLs, to reduce urban runoff pollution and improve water quality of receiving water bodies, this revenue source is inadequate. This fee can no longer support the anticipated future operating and capital expenses of the City's urban runoff management program.

The City has received many federal, state and county grants, local rebates and state loan funds to implement many BMPs. A proactive staff and supportive management have allowed the City to seek out and obtain these grants. Grants cover most if not all of the construction cost of these systems. The City provides a certain level fiscal resources for planning, design, community outreach and education, and water quality monitoring. The City also works with neighboring cities to share expenses where appropriate.

Urban Runoff Management Plan

The City recently began a major effort to codify into an urban runoff management plan its dispersed runoff management program, bringing together the activities of the City's many divisions involved in urban runoff management. To date, the City has a variety of activities to curb runoff pollution and meet the requirements of its Phase I National Pollutant Discharge Elimination System permit, through the County of Los Angeles. Almost all City divisions participate in runoff management, from legal to planning to engineering to open spaces to enforcement. Since 1990, the City has operated its program without a formalized document, a repository of all requirements, whether regulatory and City policy, a document that anyone can review, share and update—a living, dynamic document. Without such a document, City finds it difficult to present a unified and centralized approach. When other government agencies contact the City for a copy of our plan, we do not have one document to present. Though the City has many clear objectives and policies, and a Sustainable City Program, for urban runoff, the City has been lacking in a written plan.

Beginning in November 2002, the City will work with a consultant to begin a year-long process to develop this document, incorporating the latest hydrologic and hydraulic data about the City's storm drain system, GIS information and maps, regulatory requirements, and low-impact design solutions. The unique aspect of this plan is its low-impact approach, seeking watershed solutions upstream for any storm drain system deficiencies, soft and permeable BMPs instead of traditional hardscapes solutions. Wherever possible, to upgrade the storm drain system, low-impact design BMPs are preferred and requested, or the installation of treat and release systems to give a minimum of treatment to meet new standards. The plan's approach is to treat runoff as the valuable local resource it truly is, and not as a waste product to be easily discarded.

Conclusion

The City's Urban Runoff Management Program has two goals: treat runoff to the highest possible standards, given economic and regulatory realities, and release; and treat runoff and reuse it as a valuable

resource. These goals have three implementation and guiding strategies within the management plan: treat all dry weather and initial wet weather runoff before leaving the City's boundaries; harvest wet weather flows for groundwater recharge; and harvest, treat and reuse dry weather runoff for landscape and in-door plumbing purposes. These goals and strategies make up the new Urban Runoff Management Plan. What makes this plan unique is the toolbox of human, technical and fiscal resources that the City employs to reach these goals and strategies: numerous divisions working together to meet regulatory requirements; a supportive City Council and management with a Sustainable City Program with guiding principles; City employees who are trained and believe in the goals and strategies; a stormwater user fee; grants; and tested and effective technologies.

SMURRF is the centerpiece of the City's integrated urban runoff management program, being the linchpin of the City's commitment to protecting the Bay's water quality, wildlife and beachgoers, and an important best management practice for the Santa Monica Sustainable City Program. Not only can urban runoff be treated and released back into the environment, the SMURRF demonstrates the feasibility of taking a local polluted resource, urban runoff, and turning it into a valuable natural resource for reuse, helping to displace the need for more expensive and energy-intensive imported water. This BMP and those BMPs installed by new development to harvest stormwater for infiltration establish a precedence for exhausting efforts to first reuse local water resources of various qualities before turning to distant water resources, the removal of which may cause significant ecological damage and water supply disruption to distant aquatic habitats and cities. These BMPs also keep potential pollutants of concern out of surface waters, improving water quality for beneficial uses and protection of wildlife and human visitors to the ocean.

References

American Oceans Campaign, 2000. About Stormwater and Polluted Runoff, www.americanoceans.org.

Coastal Alliance, 2000. Pointless Pollution: Preventing Polluted Runoff and Protecting America's Coasts, Washington, DC.

Cone, Marla, 2000. Study Finds Widespread Runoff Peril on the Coast, Los Angeles Times, November 29.

Los Angeles County, 2000. Reducing the Health Risks of Swimming at Los Angeles County Beaches, 1999-2000 Grand Jury Final Report, 192-246.

Haile, R.W., Alamillo, J., Barrett, K., Cressey, R., Dermond, J., Ervin, C., Glasser, A., Harawa, N., Harmon, P., Harper, J., McGee, C., Millikan, R.C., Nides, M., and J.S. Witte, 1996. An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay, Final Report, Santa Monica Bay Restoration Project, Los Angeles.

May, C.W., Horner, R.R., Karr, J.R., Mar, B.W., and E.B. Welch, 1997. Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion, Watershed Protection Techniques, 2:483-494, Center for Watershed Protection, Maryland.

Mehta, S., 2002. State OKs Tough New Regulations to Reduce Runoff, Los Angeles Times, January 19.

Santa Monica, City of, 2000. Urban Runoff Mitigation Ordinance, Chapter 7.10 of the Santa Monica Municipal Code, #1992, November 28.

Santa Monica, City of, 1994. Sustainable City Program adopted by City Council, September 24.

Schueler, T. and R. Claytor, 1995. Impervious Cover as an Urban Stream Indicator and a Watershed Management Tool, Effects of Water Development and Management on Aquatic Ecosystems, ASCE, New York.

Schueler, T., 1994. The Importance of Imperviousness, Watershed Protection Techniques, 1(3), Center for Watershed Protection, Maryland.

Sheppard, H., 2000. Testing the Waters: Health of region's shores threatened by urban runoff, Daily News, Los Angeles, May 17.